

Table of excessive precipitation—Continued.

| State and station. | Monthly rainfall in inches, or more. | Rainfall 2.50 inches, or more, in 24 hours. | | Rainfall of 1 inch, or more, in one hour. | | |
|--------------------|---|--|---------|---|-------|------|
| | | Amt. | Day. | Amt. | Time. | Day. |
| Virginia. | | Inches. | Inches. | Inches | h. m. | |
| Cape Henry | | | 4.46 | 28-29 | | |
| Fall Creek Depot | | 11.37 | | 2.04 | 1 25 | 18 |
| Do. | | | | 2.05 | 1 50 | 24 |
| Norfolk | | 2.70 | | 29 | | |
| West Virginia. | | | | | | |
| Glenville | | 2.64 | | 2 | | |
| Parkersburgh | | | | 1.45 | 1 00 | 15 |
| Tyler Creek | | 3.02 | | 16 | | |
| Weston | | 2.50 | | 1 | | |
| Wyoming. | | | | | | |
| Cheyenne | | | | 1.28 | 1 15 | 4 |

Received too late for publication in June Review.

| | | | | | | |
|----------------------|--|------|-------|------|------|----|
| <i>Illinois.</i> | | | | | | |
| Cockrell | | 3.82 | 13-14 | | | |
| <i>New York.</i> | | | | | | |
| Rome | | 2.62 | 14 | | | |
| <i>Wisconsin.</i> | | | | | | |
| South Canisteo | | | | 2.12 | 1 00 | 12 |
| <i>Oregon.</i> | | | | | | |
| Potosi | | | | 1.00 | 0 15 | 3 |
| <i>Cascade Locks</i> | | | | | | |
| | | 3.11 | 18 | | | |

Reports received too late to be used in general discussion for July, 1890.

| | | | | | | |
|------------------|--|------|-------|------|------|----|
| <i>Arkansas.</i> | | | | | | |
| Lonoke | | 2.50 | 15 | | | |
| <i>Kentucky.</i> | | | | | | |
| Osceola | | 5.58 | 12-13 | | | |
| <i>Mexico.</i> | | | | | | |
| Owenton | | 3.30 | 23 | | | |
| <i>Mazatlan</i> | | | | | | |
| Guanajuato | | 2.80 | 27 | 1.42 | 0 30 | 24 |

SNOW.

Trace of snow fell at Mount Washington, N. H., 19th, and at Calais, Me., 20th.

HAIL.

Description of the more severe hail storms of the month is given under "Local storms." Hail was reported as follows: 1st, Ohio, Oregon. 2d, Colo., Md., N. Dak., Ohio, S. Dak., Tenn., Va., Wis. 3d, Colo. 4th, Ariz. 5th, Ariz. and Minn. 6th, N. Dak. 7th, Wis. 8th, Colo., Ill., Ind., Iowa, Mass., Minn., Nebr.,

N. H., N. Y., Ohio, Pa., Vt., Va., Wyo. 9th, N. C., Va. 10th, Minn. 11th, Nev. 12th, Ill., N. Dak., S. Dak. 13th, Minn., N. J. 14th, Ill., Mass. 15th, Colo., Pa., Vt. 16th, Oregon, S. Dak. 17th, Colo., Ill., N. J., Ohio, Oregon, Pa. 18th, Colo., Nebr. 19th, Conn., Mass., N. Y., Vt. 20th, Mass. 21st, Colo. 22d, Colo., Minn., Nebr., N. Dak. 23d, Colo., Ind., Wis. 24th, Colo., Mass., N. Mex., Ohio, Oregon. 25th, Mass., Minn., N. Mex., Pa. 26th, Mass. 27th, Ariz., Kans. 28th, Ariz., Colo., Minn., Utah. 29th, Ariz., Kans., Minn. 30th, Ariz., Nev., N. Dak. 31st, Colo., N. H., N. Dak.

SLEET.

Sleet was reported at Huron, S. Dak., 2d, and at Mount Washington, N. H., 20th.

MAXIMUM RAINFALLS IN ONE HOUR OR LESS.

The following table is a record of the heaviest rainfalls during July, 1890, for periods of five and ten minutes and one hour, as reported by regular stations of the Signal Service furnished with self-registering gauges:

| Station. | Maximum fall in— | | | | | |
|---------------------|------------------|-------|---------|-------|---------|-------|
| | 5 min. | Date. | 10 min. | Date. | 1 hour. | Date. |
| | Inch. | | Inch. | | Inch. | |
| Bismarck, N. Dak. | 0.06 | 7 | 0.12 | 7 | 0.65 | 7 |
| Boston, Mass. | 0.15 | 26 | 0.28 | 26 | 0.85 | 26 |
| Buffalo, N. Y. | 0.18 | 17 | 0.25 | 17 | 0.25 | 17 |
| Cincinnati, Ohio | 0.10 | 23 | 0.12 | 23 | 0.26 | 23 |
| Chicago, Ill. | 0.40 | 14 | 0.56 | 14 | 1.04 | 14 |
| Cleveland, Ohio | 0.20 | 1 | 0.35 | 1 | 1.05 | 1 |
| Denver, Colo. | 0.03 | 22 | 0.07 | 22 | 0.26 | 22 |
| Detroit, Mich. | 0.25 | 1 | 0.45 | 1 | 0.70 | 1 |
| Duluth, Minn. | 0.25 | 30 | 0.38 | 30 | 0.85 | 30 |
| Dodge City, Kans. | 0.10 | | | | 0.10 | 8 |
| Galveston, Tex. | 0.15 | 24 | 0.25 | 24 | 0.55 | 24 |
| Jupiter, Fla. | 0.43 | 21 | 0.65 | 21 | 1.30 | 21 |
| Marquette, Mich. | 0.30 | 7 | 0.45 | 7 | 0.75 | 12 |
| Memphis, Tenn. | 0.10 | 17 | 0.18 | 17 | 0.35 | 17 |
| New York City | 0.12 | 25 | 0.18 | 25 | 0.54 | 3 |
| New Orleans, La. | 0.25 | 7 | 0.32 | 7 | 1.00 | 7 |
| Norfolk, Va. | 0.25 | 18 | 0.50 | 18 | 0.82 | 28 |
| Omaha, Nebr. | | | | | | |
| Philadelphia, Pa. | 0.13 | 26 | 0.24 | 26 | 0.56 | 26 |
| Portland, Oregon | 0.03 | 8 | 0.05 | 8 | 0.10 | 8 |
| Savannah, Ga. | 0.40 | 8 | 0.70 | 8 | 1.05 | 8 |
| San Diego, Cal. | † | | † | | † | |
| San Francisco, Cal. | | | | | | |
| Santa Fe, N. Mex. | 0.10 | 1 | 0.15 | 1 | 0.45 | 19 |
| Saint Louis, Mo. | • | | • | | 0.14 | 12 |
| Saint Paul, Minn. | 0.12 | 25 | 0.15 | 25 | 0.25 | 25 |
| Washington City | 0.30 | 2 | 0.57 | 2 | 0.88 | 2 |
| Wilmington, N. C. | 0.20 | 18 | 0.35 | 18 | 1.30 | 29 |

* Not sufficient to register.

† No rain.

WINDS.

The prevailing winds during July, 1890, are shown on chart ii by arrows flying with the wind. In New England and the middle and south Atlantic states the winds were mostly from south to west; over the Florida Peninsula, easterly; in the west Gulf states, the Rio Grande Valley, the Missouri Valley, and on the southeast slope of the Rocky Mountains, south to southeast; in the Ohio Valley and Tennessee, south to southwest; in the lower lake region and over the northern plateau region, southeast to southwest; in the extreme northwest, southeast; on the northeast slope of the Rocky Mountains, over the middle plateau region, and on the middle and south Pacific coasts, southwest to northwest; on the middle-eastern slope of the Rocky Mountains and over the southern plateau region, southerly; on the north Pacific coast, north to west; and in the east Gulf states, the upper lake region, and the upper Mississippi valley, variable.

HIGH WINDS (in miles per hour).

Wind velocities of 50 miles, or more, per hour were reported at regular stations of the Signal Service as follows: 4th, 52, ne., at Chicago, Ill. 7th, 75, nw., at Moorhead, Minn. 9th, 75, nw., at Mount Killington, Vt. 31st, 80, w., at Mount Washington, N. H.

LOCAL STORMS.

On the afternoon and evening of the 1st heavy rain and thunder-storms, attended in places by hail, occurred in various sections of Ohio, causing great damage to property and crops by flooding streams, etc. On the 2d a severe thunder-storm, with heavy rain, prevailed in northeast New Jersey; the operation of electric wires was interrupted, and a number of buildings in Paterson were struck by lightning. A cloud-burst in the mountains washed out the tracks of the Texas Pacific Railroad in El Paso Co., Tex., on the 3d. A heavy gale prevailed over Lake Michigan the night of the 3d and during the 4th, causing some damage to shipping. On the 4th a heavy rain storm occurred at and near Milford, N. J., in the afternoon, flooding small streams, drowning one child, and causing loss to live stock, buildings, and crops to the extent of about \$100,000. A report from Parkersburgh, W. Va., dated the 5th, stated that heavy rain had caused immense damage in that section, and the loss by flood in the Muskingum Valley, Ohio, was estimated at \$500,000. On the 5th a heavy thunder-storm, without rain, passed over Spartanburgh, S. C.; at Campobella, S. C., rain fell heavily, badly washing lands and carrying away dams in that section. On the 7th one of the most terrific thunder-storms in the history of that

section occurred at Moorhead, Minn., in the early morning. About midnight, 6th, lightning, which had been observed in the nw. and w., became more frequent, accompanied by heavy thunder, and approached rapidly from the nw., seeming to increase in strength as it advanced. At this time the wind sprang up from sw. and about 3.22 a. m., 75th meridian time, it increased to 25 miles per hour. At 3.30 a. m. it suddenly changed to northwest, increasing almost instantly in force. At 3.35 a. m. a violent gust began, during which the wind attained a velocity of about 75 miles per hour. The wind then suddenly diminished in force and changed to the westward. While the storm was raging it was almost impossible to observe the clouds, but from what could be seen the storm could not be called a tornado, but would be classed as a very violent thunder-storm, with vivid flashes of zigzag lightning occurring incessantly. Great damage to property was caused in Moorhead, and in Fargo, N. Dak.; 7 persons were killed and 13 injured. The instrument shelter of the signal office was torn to pieces by the wind and some parts of it could not be found. At 4.30 a. m. the station barometer read 28.83, corrected for temperature only. The damage to property in Fargo was estimated at \$75,000, and in Moorhead at \$25,000. A violent wind and electrical storm swept over the Lake Superior district, Wisconsin, in the early morning, demolishing buildings, prostrating trees, etc.

On the 8th, a storm passed over Lake Champlain about 3.30 p. m., moving in an easterly direction. It struck Groveton, N. H., at 5 p. m., and passed thence to the Maine coast. The storm was very violent throughout its course; a number of persons were killed, buildings were demolished, and forests and orchards levelled. At Plattsburgh Barracks, N. Y., the wind blew with great force from 4.30 to 4.45 p. m., damaging buildings, breaking the flag-staff, and blowing down trees. The Bluff Point Hotel, Lake Champlain, was damaged to the extent of about \$5,000. Several persons were drowned on Lake Champlain by capsizing of boats. The storm was also very severe in Vermont, New Hampshire, and Maine, and was attended throughout by thunder and lightning. A number of persons were killed and many injured by falling buildings and trees. Severe electrical storms were reported in Ontario, Canada. At Erie, Pa., a thunder-storm, with rain and high wind, continued from 6.36 to 9 p. m.; one person was killed and two buildings were struck by lightning. At Cleveland, Ohio, a severe thunder-storm, with terrific wind gusts and small hail, advanced from the nw. in the evening; electric wires were damaged, a number of houses were blown down or damaged, and the loss to property was estimated at \$100,000. Severe electrical storms were reported throughout northwest Pa., northern Ohio, central and western Ind., and upper Mich. On the 9th a thunder-storm passed over Chattanooga, Tenn., from 3.10 to 5.10 p. m.; lightning struck in several places; several persons were injured, and damage was caused to electric wires. A heavy hail storm, moving from the northwest, caused considerable damage in Atlantic Co., N. J., the night of the 12-13th.

On the 13th, about 6 p. m., 75th meridian time, a tornado swept over New Canada township, Ramsey Co., Minn., causing the death of 6 persons, and injuring 23, demolishing buildings, uprooting trees, etc. The damage to buildings was estimated at \$2,000, to crops \$7,500, and to animals \$500. A funnel-shaped cloud was observed moving toward se., or s. 25° e., attended by a roaring sound. The rainfall was heavy and most abundant before the passage of the cloud; hail-stones large enough to kill chickens fell some distance north of the path of destruction, and a few small hail-stones in the path; the tornado cloud had a whirling motion from right to left; it was attended by loud and frequent thunder and intense sheet and zigzag lightning, and articles were carried up by the storm. On the north side of the storm-track trees, etc., were thrown northeastward, on the south side, southeastward, and in the centre they were confused and indefinite. All buildings destroyed were wooden and of slight structure, and were

actually torn into shreds. Foliage was stripped from trees and plants, and near the ruined buildings the trees were barked, possibly by flying débris. The area of destruction was about $\frac{1}{2}$ mile in length and from 400 to 800 feet in width. A remarkable feature of the storm was that 500 to 800 feet back of the buildings first destroyed, and from the commencement of the path of destruction, sticks of timber, which were unquestionably portions of the buildings demolished, were found driven into the ground, the smaller or lighter ends being invariably downward. These sticks were apparently drawn upward and thrown backward from the storm with a force much greater than that resulting from gravitation. A remarkable effect of the storm's action was shown in the wreck of a buggy which was found about 75 feet from the place where it had been left in good condition. The axles and springs were uninjured and both nuts were on the ends of the fore axle, but the hubs were gone. A hub and nut remained on one end of the hind axle, but the hub and nut on the other end were gone; the nut had not been unscrewed but had been forced off by tearing away the screw thread. About 9 p. m., 75th meridian time, a violent storm passed over Lake Pepin (Mississippi River), 50 miles southeast from Saint Paul, Minn., and overturned the excursion steamer "Red Wing" with over 200 persons aboard; 100 of these were drowned. The estimated loss to buildings in Lake City, a few miles from the scene of the disaster, was \$10,000. On the 16th severe storms occurred throughout southeastern Minn. and northern Ind. During an electrical storm electric plants were burned out, houses struck, and persons shocked by lightning in Bangor, Me. A heavy thunder-storm occurred at Spartanburgh, S. C. On the 17th thunder-storms, with heavy rain, high wind, and hail, occurred in central and eastern N. J.; a number of buildings were struck by lightning and several burned; trees were blown down and buildings were damaged. In Mercer Co., N. J., a destructive hail storm occurred. In Hunterdon Co., N. J., crops were damaged by hail. The amount of damage was estimated at \$30,000. At Trenton, N. J., 2 men were killed by lightning while under a tree, and the wind caused about \$2,000 damage to buildings. One of the heaviest electrical storms in years occurred at Woodbury, N. J., in the evening. In the Western Union and railroad telegraph offices the wooden casing about the wires was fired by electricity. A barn was struck by lightning and burned, causing a loss of about \$7,000. At Philadelphia, Pa., a faint thunder-storm was first heard at 5.40 p. m.; at 7.45 p. m. there was a violent gust of wind from the northeast which attained an extreme velocity of 42 miles per hour, with torrents of rain for a few minutes; during the next 2 hours lightning and thunder were incessant. Great damage was caused to property in the north part of the city, and heavy hail fell in the northeast part of the city and the adjoining country. Great damage to property was reported in Montgomery and Lehigh counties, Pa. A heavy thunder-storm, with small hail and heavy rain, prevailed at Lansdale, Pa., from 7 to 8 p. m. The storm moved from s. to n., then turned and moved s. A number of buildings and trees were struck by lightning. At Osceola, Pa., heavy rain fell; buildings were swept away, and two women were drowned. About 4 p. m. a heavy rain and wind storm moved se. over Allentown, Pa., with light thunder and a few flashes of lightning; one person was killed by a falling building, and property was damaged to the extent of about \$20,000. About 4 p. m. a heavy rain and hail storm with thunder and lightning moved east over Girard, Pa., damaging property to the value of about \$1,000. About 4.30 p. m., eastern time, a heavy thunder, rain, wind, and hail storm moved southeast over Hellertown, Pa., killing one person, injuring several, and destroying property to the value of about \$40,000. About 8 p. m. a thunder-storm, with heavy rain and large hail, moved ne. over Reading, Pa., a number of buildings were struck by lightning, and several persons were stunned. At 5.40 p. m., eastern time, a thunder-storm, with heavy wind, rain, and large hail, moved se. over Ashland, Pa., destroying buildings to the value of

about \$50,000. A thunder-storm, with heavy rain, moved se. over Marshall, Ill., about 5 p. m., central time. A tornado, moving in a zigzag e. of s. course, occurred at Wesley, Ill., at 2.40 p. m., central time; the funnel resembled a huge writhing serpent, and was attended by a roaring sound; the rainfall was heavy, and more abundant after the passage of the tornado; no hail fell; lightning played up and down the funnel with frequent roars and sharp cracks; one man was killed and two others received severe shocks by lightning; trees were twisted off, and pieces of wood, stones, etc., were seen in the funnel; the position of trees and timbers along the track of the storm indicated two currents, one travelling n. and the other s., the northern current being the stronger; buildings were damaged to the value of about \$3,000. Severe electrical storms occurred in Frederick and Washington counties, Md.

On the 18th a violent thunder-storm, with heavy rain, began at Southport, N. C., at 11 p. m., and continued until 6 a. m., 19th, during which 5.05 inches of rain fell; the heavy rain caused streams in the vicinity to rise rapidly, washing away bridges, etc. A heavy thunder-storm moved southeast near Metropolis, Ill., at 9 p. m., central time; two barns and several wheat and hay stacks were struck by lightning and burned. Severe electrical and rain storms occurred in sections of Ill., Mo., and Iowa. On the 19th a thunder-storm, with heavy rain, began at Omaha, Nebr., at 1.05 a. m. and ended 1.05 p. m.; the heavy rainfall caused bursting of sewers, flooding of cellars, etc. A severe electric, rain, and wind storm occurred at Pacific Junction, Iowa, about 2 a. m., demolishing 3 buildings. On the 20th, about 2.30 a. m., a violent thunder-storm began at Yankton, S. Dak., attended by the heaviest rainfall since the establishment of the Signal Service station in 1873; from 2.30 to 4.40 a. m., 2.44 inches fell; the damage done by the storm was slight. A severe thunder-storm occurred in the morning at Irwin, Iowa, damaging stock and property to the value of about \$2,000. On the 21st two small tornadoes were reported by surveyors about 10 miles northwest from Fort Bennett, S. Dak.; in each case the funnel-shaped cloud was well-defined, the lower extremity swaying backward and forward before reaching the ground; both moved from the southeast, and lasted about 15 minutes; one of the funnels apparently broke over the Cheyenne River, and the other, after contracting and elongating several times, withdrew within the cloud and disappeared; no damage was caused, the country being uninhabited. A heavy thunder-storm, with excessive rain, occurred at Cheyenne, Wyo., in the afternoon; streets were flooded, and damage caused by water. Severe wind storms were reported in Quebec, Can.

On the 22d a tornado, moving se., reached Marshall, Minn., at 6.10 p. m., central time, with moderate rain, and hail the size of peas, thunder, and lightning; the funnel had a rotary motion, and objects were carried up; one person was killed and several injured; property was damaged to the value of about \$4,000. The day had been hot and the magnetic needle much disturbed from 2 to 4 p. m. At 5.30 p. m. a dark cloud extended from e. 20° n. to ne., surmounted by cumulus clouds, the southern side being illuminated; at 5.30 p. m. it was broken or ragged, with lightning in the direction of Westerheims, 8 miles ne., and 24 seconds later came the thunder. In the ne. light cirro-stratus clouds were seen to move rapidly ne. over the background of dark stratus along the horizon. At 6 p. m. the tornado cloud was seen approaching Marshall with a funnel formation which met a column or pillar which rose from the stratus below. Finally the upper cumulus was liberated and borne directly over Marshall at an estimated height of 400 feet. There was a heavy shower of large drops at 6.10 p. m., and a few hail-stones. The path of the tornado, measured in a field, was 210 feet wide, and was divided into the middle, 90 feet, and the outer areas, each 60 feet wide. In the middle of the path were several conical depressions in the dust; as if a top 4 inches in diameter had revolved in the ground. This storm first appeared about 2 miles nw. of

Ghent, Minn., about 7 miles nw. of Marshall, and moved thence se. to Marshall, with destructive violence at points along its path. At 12.10 p. m., central time, a tornado occurred about $\frac{3}{4}$ mile north of Galesburg, Traill Co., N. Dak., moving e. by n.; very light rain fell before and none after the passage of the tornado; no hail fell; the funnel cloud was attended by thunder and lightning, and had a whirling motion from right to left; debris was scattered from n. of storm track in all directions around to se. The storm first appeared as a small prairie twister; 13 minutes later it connected with a funnel-shaped cloud above by a small rotating tubular cloud; the storm then appeared to gain strength, and at 12.16 p. m. destroyed a house; time and distance being noted, showed a travelling speed of 12 miles per hour for the tornado cloud, and by triangulation the height of the funnel-shaped cloud was shown to be 4,700 feet above the ground. At 12.10 p. m. the "twister" was about 10 feet in diameter; at 12.16 p. m. about 30 to 40 feet, the connecting cloud between the storm cloud near the ground and the funnel-shaped cloud above apparently varying from the size of a man's wrist to 3 feet in diameter; sods and dirt were seen to go up in the cloud; injured persons were standing just outside of houses, and were drawn into flying debris by suction of storm. Two persons were injured, and the loss to property was about \$300. About 3 p. m., central time, a tornado passed se. over Pleasanton, Nebr., with heavy rain and small hail; no thunder and lightning; articles were carried up in the storm; the funnel revolved from right to left; no persons were killed or injured; buildings were injured to the extent of about \$5,000. Considerable damage was caused to railroad and other property by heavy rain in central Colorado.

On the 23d a severe electrical storm visited Sheboygan, Mich., and some damage was caused by lightning. On the 24th a gale, with heavy rain, began at Pensacola, Fla., and lasted 17 minutes, the wind attaining a velocity of 48 miles per hour and an extreme velocity of 67 miles per hour; much damage was caused to corn and bridges in the surrounding country. A severe thunder-storm passed over Port Huron, Mich., in the evening; a number of buildings were struck by lightning, and excessive rainfall caused some damage to crops. Reports of the 28th stated that heavy rain had caused damage to crops and property by flood in parts of North Carolina, South Carolina, and Alabama. A cloud burst occurred at Bisbee, Ariz., in the evening, washing away 3 miners' cabins; two lives were lost, and the damage to property amounted to \$10,000. A heavy storm, with hail, occurred at Losee, Utah, at 2 p. m., lasting 25 minutes and causing much damage to crops. A severe wind and hail storm occurred in the evening at Morris, Minn., damaging grain and fruit. On the evening of the 30th a severe thunder-storm occurred at Mount Huachuca, Ariz. It was reported the heaviest storm in that section in years; some hail fell; much damage was done to bridges and wells. On the 31st heavy thunder, rain, and wind storms prevailed generally in New England in the afternoon. The storm was very severe on Lake Winnepesaukee, N. H., where two water-spouts were observed, and along the Maine and New Hampshire coasts; a number of buildings were struck and stock was killed by lightning.

Lawrence, Mass., Tornado, July 26th.

This tornado struck South Lawrence at 9.10 to 9.15 a. m. It was about 2 minutes in passing any point, but in that time damage amounting to \$50,000 to houses and \$10,000 to bridges, fences, trees, etc., was done. Eight persons were killed. Full reports from H. F. Mills, R. H. Tewksbury, and others have been received, as well as a map from the former showing the destruction among the trees in Union Park. The first report of an unusual storm comes from Fiskdale, Mass., 68 miles southwest of Lawrence, as follows: "At 7.50 a. m. some trees were torn up with roots, and others broken and twisted off. The path was about 4 rods."

A second report comes from North Billerica, Mass., 12 miles southwest of Lawrence, as follows: "Rain cloud with 'white bone in mouth,' high sw. wind, breaking large limbs from trees and unroofing light buildings; motion rotary; duration about 8 minutes at 9.00 a. m." A third report is from Newburyport, Mass., 17 miles northeast of Lawrence. There was a peculiar boiling up noticed with a very black line of cloud moving rapidly toward the east at 9.32

a. m. The time at Lawrence is given as 9.10 by one man and 9.15 by another. Assuming this time as 9.13 we have the following velocities of progression: Fiskdale to N. Billerica, distance, 51 miles; velocity, 44 miles per hour. N. Billerica to Lawrence, distance, 12 miles; velocity, 55 miles per hour. Lawrence to Newburyport, distance, 17 miles; velocity, 54 miles per hour.

These results are very satisfactory, and show a velocity of nearly a mile a minute near Lawrence. On examining the weather map just an hour before the tornado we find a general storm of slight intensity central 350 miles to the northwest of Lawrence. The velocity of this storm was 39 miles per hour. Reports from more than 30 stations about Lawrence show that just at this time, or a little before, the wind was gentle and from a southerly direction. Clouds were moving from following directions at 8 a. m.:

Southwest: Killington Peak, Vt.; Northfield, Vt.; New London, Conn.; Block Island, R. I.; Nantucket, Mass.; Mount Washington, N. H.

South: New Haven, Conn.; Boston, Mass.; Manchester, N. H.; Portland, Me.; Green Mountain, Me.; Eastport, Me.

The directions of clouds are shown slightly from sw. to the west of Lawrence but emphatically from s. near that town and on the east side. The wind at Killington was sw. 30; Mt. Washington, sw., 32; Green Mountain s. 34, with maximum in 12 hours of 60 s.

The tornado first struck about $\frac{1}{4}$ mile west of Lawrence in an orchard which it damaged. It then passed to the grounds of the Cricket Club (several acres inclosed by a tight board fence 8 ft. high). This fence was levelled, and, except for a short distance on the southwest corner, was thrown outward from the centre in every direction. Farther on the tornado struck two dwellings on Emmet street, the most westerly in the city proper; one of these was carried east and nearly ruined, the other was completely demolished, with loss of life and buildings damaged. Just east of this the Essex Company's "Old Blue Ledge," an abandoned stone quarry, deflected the tornado upward over a thickly populated region and the houses escaped with the loss of chimneys. Cutler's house on Salem street was destroyed and near here, "just at one side of the track of the current," a portion of the roof of a church was lifted from the walls, as would happen if an outreaching arm of the cloud by powerful suction operating upon a particular point had produced the result, this was singular, inasmuch as the main building, higher and nearer the main current, was practically uninjured. From this point the progress was for some 100 rods or more across open ground to Springfield street, where the most damage was done to buildings and where the greatest loss of life occurred. "There seemed to be, at times, two whirls in the cloud, diverging slightly and reuniting as all swept swiftly on in a general direction slightly north of east. Here some buildings, apparently in the direct track, were left untouched or only slightly damaged while those on either side were demolished. In one case a large three-storied block was nearly stripped of the easterly, northerly, and westerly outer walls, the interior partitions and rooms appearing but little damaged, furniture and plastering therein remaining in position. Another large three-storied block upon the north side of the tornado's track appears to have been lifted from foundations and thrown south some 20 feet into the street, as would occur from a powerful suction upward and toward the centre." "At another point near the park a building upon the south side of the whirl was unroofed and thrown from foundation outward some 15 feet toward the

southeast, while nearly opposite, upon the north side of the whirl, a large dwelling was thrown outward northerly or more exactly toward the northwest. These cases are exceptional; the general position of debris, etc., indicates a powerful draught toward the centre and in the direction of movement."

A house on the corner of Market and Union streets, one block north of the track, was moved 8 feet to the west. On the north of the track and near it north windows of houses were invariably blown into the rooms, and small trees in the back yards were broken toward the south, or toward the path of the storm. In one case a small house that stood back of a house on the north of the street was blown southwest against a dwelling house and this in turn was strewn in fragments southeast. An interesting action was found in Union Park. A map showing the distribution of fallen trees will be found on the back of chart i. The characteristic indrafts on the right-hand side, and extending to 200 feet and more from the track, are well shown. There are a few trees on the left-hand side which indicate a counter current or a pushing through of the current on the right side, but the general position of the trees is, just as in the case of the houses, toward or in the direction of the tornado.

General direction of path was N. 60° E., about 35 houses were demolished or injured, 8 persons were killed and 68 injured. Very heavy rain fell before the tornado, and but little after its passage; no lightning or thunder was reported, and no hail fell; great quantities of timber and other articles were carried up and forward.

The cloud passed near one man working about one mile east of the town. It unroofed a barn (the first building injured) and then passed on through a grove. He described it as a large cloud rolling over and over. He heard a loud roar. Another observer saw the black cloud half mile away. He saw through the heavy rain what appeared to be two clouds chasing each other around in a whirl, the cloud in front was moving northerly. Another observer saw the top of the cloud rolling forward faster than the bottom, like the upper part of a wagon wheel.

WATER-SPOUT.

Pensacola, Fla., 21st: a well-defined water-spout was observed 3.30 p. m., 75th meridian time, near the middle of Escambia Bay, about $6\frac{1}{2}$ miles east-northeast of this city. It moved in a westerly direction to the shore of Magnolia Bluff, a distance of about $2\frac{1}{2}$ miles, in about 10 minutes. Observers report that the cloud presented the usual funnel shape, with the swell at the base. The column had an undulating, serpentine-like motion, and was estimated to be about a mile in length from the surface of the water to the contact with the cloud above, and about 25 feet in diameter. The water appeared to be sucked up a distance of about 10 feet, above which the column resembled mist or cloud. On reaching the shore the column broke at a point about $\frac{1}{2}$ of its height, and in about 5 or 6 minutes it had dissipated.

INLAND NAVIGATION.

STAGE OF WATER IN RIVERS AND HARBORS.

The following table shows the danger-point at the several stations; the highest and lowest water during July, 1890, with the dates of occurrence and the monthly ranges:

Heights of rivers above low-water mark, July, 1890 (in feet and tenths).

| Stations. | Danger-point on gauge. | Highest water. | | Lowest water. | | Monthly range. |
|---------------------------|------------------------|----------------|---------|---------------|---------|----------------|
| | | Date. | Height. | Date. | Height. | |
| Red River: | | | | | | |
| Shreveport, La. | 29.9 | 1 | 11.1 | 31 | 1.4 | 9.7 |
| Arkansas River: | | | | | | |
| Fort Smith, Ark. | 22.0 | 1 | 3.8 | 22 | 0.5 | 3.3 |
| Little Rock, Ark. | 23.0 | 2 | 7.3 | 31 | 4.0 | 3.3 |
| Missouri River: | | | | | | |
| Fort Buford, N. Dak. | | 1 | 11.0 | 31 | 6.2 | 4.8 |
| Sioux City, Iowa. | | 7 | 11.8 | 31 | 9.0 | 2.8 |
| Omaha, Nebr. | 18.0 | 8 | 11.6 | 31 | 9.3 | 2.3 |
| Kansas City, Mo. | 21.0 | 15 | 14.5 | 31 | 10.2 | 4.3 |
| Mississippi River: | | | | | | |
| Saint Paul, Minn. | 14.5 | 1 | 5.7 | 31 | 2.7 | 3.0 |
| La Crosse, Wis. | 24.0 | 1 | 8.0 | 31 | 4.4 | 3.6 |
| Dubuque, Iowa. | 16.0 | 1 | 12.5 | 31 | 4.7 | 7.8 |
| Davenport, Iowa. | 15.0 | 1 | 10.9 | 31 | 3.0 | 7.9 |
| Keokuk, Iowa. | 14.0 | 1 | 12.6 | 31 | 3.2 | 9.4 |
| Saint Louis, Mo. | 32.0 | 1 | 20.5 | 31 | 10.9 | 9.6 |
| Cairo, Ill. | 40.0 | 2 | 23.3 | 24-27 | 12.5 | 10.8 |
| Memphis, Tenn. | 34.6 | 1 | 18.6 | 27 | 10.3 | 8.3 |
| Vicksburg, Miss. | 41.0 | 1 | 28.5 | 31 | 13.0 | 15.5 |
| New Orleans, La. | 13.0 | 1 | 10.6 | 31 | 4.5 | 6.1 |
| Ohio River: | | | | | | |
| Pittsburgh, Pa. | 22.0 | 28 | 6.2 | 12 | 1.3 | 4.9 |
| Parkersburg, W. Va. | 38.0 | 3 | 13.3 | 29, 31 | 2.8 | 10.5 |

Heights of rivers—Continued.

| Stations. | Danger-point on gauge. | Highest water. | | Lowest water. | | Monthly range. |
|------------------------------|------------------------|----------------|---------|----------------|---------|----------------|
| | | Date. | Height. | Date. | Height. | |
| Ohio River—Continued. | | | | | | |
| Cincinnati, Ohio. | 50.0 | 6, 7 | 19.0 | 18 | 6.1 | 13.9 |
| Louisville, Ky. | 25.0 | 7, 8 | 8.5 | 30, 31 | 4.4 | 4.1 |
| Cumberland River: | | | | | | |
| Nashville, Tenn. | 40.0 | 5 | 3.4 | 18, 19, 21, 22 | 1.5 | 1.9 |
| Tennessee River: | | | | | | |
| Chattanooga, Tenn. | 33.0 | 28 | 7.7 | 17 | 2.0 | 5.7 |
| Monongahela River: | | | | | | |
| Pittsburgh, Pa. | 29.0 | 28 | 6.2 | 12 | 1.3 | 4.9 |
| Savannah River: | | | | | | |
| Augusta, Ga. | 32.0 | 26 | 18.3 | 16 | 5.0 | 13.3 |
| Willamette River: | | | | | | |
| Portland, Oregon. | 15.0 | 1 | 12.4 | 28, 29, 30 | 7.0 | 5.4 |

LOW WATER.

Ohio River.—Navigation between Parkersburgh, W. Va., and Pittsburgh, Pa., was suspended on the 16th on account of low water.

Cumberland River.—Navigation closed on the 14th at Nashville, Tenn., on account of low water.

Arkansas River.—On the 22d the river at Fort Smith, Ark., was lower than it had been since April, 1887.

HIGH TIDES.

The tide was unusually high at Pensacola, Fla., on the 23d, and at Key West, Fla., on the 31st.

LATHING AND PLASTERING
DEPOSITED HERE